

The Forms of *Culex (Culex) bitaeniorhynchus* Giles
in Southeast Asia¹

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INTRODUCTION

Culex (Culex) bitaeniorhynchus Giles, 1901 is common and very widely distributed in Southeast Asia and other parts of the Oriental region. Its breeding sites are restricted to large and more or less permanent ground pools, such as swamps, ponds, bogs and obstructed streams which contain masses of filamentous green algae. Previous reports on the bionomics and medical importance of *bitaeniorhynchus* are rather conflicting and apparently less extensive than for any other of the common species of *Culex (Culex)*. It was reported to bite and feed on man in Malaya (Williamson and Zain, 1937), New Guinea (Bonne-Wepster, 1956) and Russia (Chagin, 1948), but to feed almost exclusively on birds in Singapore (Colless, 1959) and in Japan (Sasa and Sabin, 1950). These conflicting reports indicate, as suggested by Colless (1959), that *bitaeniorhynchus* may consist of a number of distinct forms, with diverse feeding habits. The true identity and the taxonomic status of this species has been most elusive, confused and by no means settled, judging from the previous taxonomic treatments (Barraud, 1934; Delfinado, 1966; Bram, 1967; LaCasse and Yamaguti, 1950).

Morphologically, *bitaeniorhynchus* is so variable that it is difficult to characterize and to analyze taxonomically. It is perhaps the most remarkable member of *Culex (Culex)*, exhibiting striking and discontinuous variations in the color of adults. In certain localities of Southeast Asia, various different color forms have frequently been found in the same population or from the same breeding site, and a number of these color forms can be readily recognized. The taxonomic references and synonymy of *bitaeniorhynchus* are very complicated; about 9 or 10 forms have been recognized and named in the Oriental region: *bitaeniorhynchus* Giles, 1901, *ager* (Giles, 1901) and *ambiguus* (Theobald, 1903) from INDIA; *taeniorostris* (Theobald, 1907) from CEYLON; *infula* (Theobald, 1901), *tenax* (Theobald, 1901) and *domesticus* (Leicester, 1908) from MALAYA; *tenax ocellata* (Theobald, 1907) and *sarawaki* (Theobald, 1907) from BORNEO; and *karatsuensis* Mochizuki, 1913 from JAPAN. All of these nominal taxa were considered conspecific with a single variable species by Edwards (1913, 1922, 1932) who in 1922, distinguished the adults of type form (*bitaeniorhynchus*), 3 varieties (*tenax*, *ambiguus* and *domesticus*) and 2 other unnamed forms. Edwards' synonymies were based exclusively on the similarity in the phallosome of the male genitalia, and most authors have followed his classification up to the present time.

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The present study is an attempt to analyze the variability of *bitaeniorhynchus* populations in all associated stages from several reared collections. This study was stimulated by the discovery that some of the striking color forms are found only in certain areas, particularly towards the south in the Indomalayan area and appear to be rare or completely absent towards the north in Thailand, Hainan, Hongkong, and up to the northeastern Palaearctic in Japan and Korea. Although the possibility exists that the variations encountered in *bitaeniorhynchus* populations are due to polymorphism, it appears more probable that the complex diversity in *bitaeniorhynchus* populations may be due to hybridization between forms which have come into contact in some areas. The present analysis merely evaluates certain striking variations in the adults and differentiates forms both on the basis of correlated characters in all stages and on distribution. Because of a lack of specimens from progeny rearings, the preliminary results presented are by no means conclusive, although a number of forms mentioned probably represent distinct species. The primary purpose here is to distinguish these forms on a strictly morphological basis in order to facilitate their identification or recognition in the field by workers investigating their medical importance. The evaluation of characters and the differentiation of forms will also provide a basis for determining the specific status of this species in an up-coming revision of Southeast Asian *Culex* (*Culex*).

I hope this analysis will stimulate fellow workers in Southeast Asia to provide more specimens from both individual and progeny rearings as well as stimulate other specialists to investigate the problems in genetics, cytogenetics and the mechanism of diversification of this interesting species or species complex.

EVALUATION OF VARIATIONS AND DIFFERENTIATING CHARACTERS

The adults, male genitalia, pupae and larvae of almost all Oriental forms of *bitaeniorhynchus* can be generally identified and recognized by the keys, figures and descriptions of Barraud (1934), LaCasse and Yamaguti (1950), Delfinado (1966) and Bram (1967). Of all stages, the larva and pupa are most diagnostic and can be readily separated from nearly all Southeast Asian *Culex* (*Culex*) species except *C. pseudosinensis* Colless, 1959. The evaluation of variations discussed below is limited to the most striking or obvious characters showing a high degree of frequency in several local populations of *bitaeniorhynchus*.

ADULTS. The conspicuous variations which are more or less significant in the general external features of adults are:

(1) Color of scales on vertex of head. The color of the erect forked scales on vertex varies from completely black or dark brown to partially pale, beige, yellow, golden or bronzy in the center and dark brown or black on posterolateral areas. This character is subject to a great deal of individual variation, but appears to be of some value in differentiating certain forms.

(2) Color of scales on mesoscutum and scutellum. The scales on the mesoscutum vary from whitish, yellow, golden or bronzy on anterior 2/3 up to the level of anterior wing roots, to predominantly dark, completely deep chestnut brown or almost black on posterior 1/3. In forms which exhibit predominantly or completely dark scales, a variable number of golden or bronzy scales forming spots, streaks or blotches on mid-acrostichal, dorso-central, fossal and humeral areas may be present. The same is true for those forms with predominantly pale scales on anterior 2/3 of mesoscutum, but with or without dark spots on the middle of fossa. The scales on the prescutellar space may be partially pale or completely dark. The scales on scutellar lobes may be entirely dark or partially pale towards the apical margin.

(3) Speckling of legs. The speckling of legs, if present, primarily involves the anterior and lateral dorsal surfaces of the femora and tibiae and varies from entirely dark to lightly, moderately or heavily speckled with pale yellowish, golden scales, producing a salt and pepper appearance. The speckling may be restricted to the anterior apical half of all femora or only to mid- and hind femora.

(4) Speckling of wings. The dorsal plume scales on the veins vary in color, as on the legs, from entirely dark to predominantly yellowish or golden intermixed with black ones producing a variable degree of speckling (light, moderate or heavy). In most forms, the speckling of the wing is usually more extensive in females than in males and appears to be correlated, to some extent, with the degree of speckling of legs.

(5) Pattern of banding and degree of speckling of abdominal terga. These characters appear most important in differentiating adult forms. The yellowish complete bands on terga II-VII may be narrow or broad; apical, basal or both. In certain forms, terga II-IV are entirely dark with variable amount of speckling, terga V-VII may be predominantly dark or with apical yellowish bands, and tergum VIII with both basal and apical bands or sometimes completely yellowish. In some forms with dark abdominal terga II-IV or II-VII, apicolateral yellowish patches may be present or absent. The dark areas of all abdominal terga vary from lightly, moderately to heavily speckled.

MALE GENITALIA. The significant variations in certain structures of the male genitalia are:

(1) Apical spiculate portion of inner division of lateral plate of phallosome (or the "ventral cornu" of most authors). This part of the lateral plate is somewhat beaklike when viewed from lateral aspect; is bent at about a 90° angle from the main proximal part and is variable in length but appears to be more or less constant in shape. It can be roughly differentiated into 3 distinct types: (1) long, typically beaklike with smoothly curved apical margin and an obtuse apical tergal angle (Fig. 1A); (2) as in (1) but apical margin with emargination proximally and with apical tergal angle produced into a point (Figs. 1B, C); and (3) short, stout with apical sternal and tergal angles more or less equally produced into points (Figs. 1D-F).

(2) Basal sternal process of proctiger. The length of the basal sternal process of the proctiger varies from 0.01 to 0.08 mm. The longer process is relatively darker and thicker than shorter ones. This is of some differentiating value when used in combination with the type of phallosome as indicated above.

PUPA. Significant variations in pupal characters known to be correlated with certain adult forms are as follows:

(1) Pigmentation of cephalothorax and abdomen. The cephalothorax and abdomen vary from pale whitish or yellowish with indefinite darkened areas to entirely dark brown. In forms which are uniformly yellowish brown there are usually distinct lateral or also median basal dark spots on abdominal terga V-VIII.

(2) Color surrounding alveoli of abdominal hairs. In forms with pale abdomen, the integument immediately surrounding the alveoli of all abdominal hairs is usually very darkly pigmented, producing a striking pattern of dark spots on all segments. This feature has been found to be quite constant and useful in differentiating sympatric forms in several local populations. In dark pupal forms, the area surrounding the alveoli of abdominal hairs is concolorous with the rest of the integument.

(3) Color of paddle. In dark pupal forms, the paddle is usually entirely pale, in others, it is usually darkened on the inner part, pale on outer part. The external margin on basal 0.5-0.75 of the outer part may be pale, indistinct or very dark, contrasting with the pale areas towards midrib.

(4) Chaetotaxy. The number of branches of the following hairs have been found to be significant: (1) metanotal hair 11-C single or double; (2) abdominal hairs 3-I-III single or double.

LARVA. The following features of the larva are useful in differentiating forms:

(1) Degree of development of abdominal hairs. The length and thickness of most abdominal hairs, except hairs 6-I-VI and 7-I, vary from very weak and indistinct to rather strong and conspicuous.

(2) Branching of abdominal hairs 1-III-VI. These hairs vary from weak, indistinct, with 2-3 branches, to strong, distinct with an average of 4 branches (3-5).

(3) Branching of abdominal hairs 4-V-VI. Abdominal hair 4-V varies from weak, pale and indistinct, with 7-9 branches, to strong, dark, distinct with an average of 10 or more branches (10-15). Hair 4-VI varies from 3-7 branches.

(4) Number of comb scales on abdominal segment VIII. In most forms, there are 4-5 large spinelike comb scales, but in certain forms these are smaller, 9-12 in number.

(5) Number of subventral tufts of siphon. The total number of subventral hair tufts of siphon varies from 6 to 8 (3-4 pairs) and is useful in separating the typical form of *bitaeniorhynchus* from the rest of the complex.

DIFFERENTIATION OF FORMS

Effort has been made to associate the various color forms of *bitaeniorhynchus* adults with the known existing types of the previous nominal forms. When these appear to agree in most features with a particular type, the original name which was attached to that type is adopted. Since most of the types are females, some of the names followed here should be considered provisional for there is marked sexual dimorphism, presenting difficulties in assigning both sexes to the same nominal taxon. However, since this study is based on the correlation of characters in all stages and on specimens from the type localities of all Malayan forms, I am confident that most of the associations attempted here are correct. Those specimens or series of reared specimens which do not appear to agree with any known type will be fully treated as forms and named after the localities where they were found.

Based on this study, there appear to be at least 5 recognizable forms of *bitaeniorhynchus* within Southeast Asia: *bitaeniorhynchus* (typical form), *tenax*, Selangor form, Luzon form and *domesticus*. All stages of these forms are diagnosed in the keys and followed by a brief characterization. To insure proper identification, all the characters presented in the keys and diagnosis should be examined.

KEYS TO FORMS OF CULEX BITAENIORHYNCHUS
IN SOUTHEAST ASIA

ADULT MALE AND FEMALE

1. Abdominal terga II-VII with broad apical yellowish bands only; legs and wings heavily speckled; anterior 2/3 of mesoscutum predominantly pale scaled *bitaeniorhynchus* (typical form)
Abdominal terga II-VII dark or with narrow apical yellowish bands, median basal pale spots or complete basal bands; legs and wings mostly dark or lightly to moderately speckled; anterior 2/3 of mesoscutum pale or completely dark scaled 2
- 2(1). Anterior 2/3 of mesoscutum predominantly dark; legs and wings lightly, moderately or heavily speckled *domesticus* form
Anterior 2/3 of mesoscutum predominantly pale; legs and wings completely dark, lightly or moderately speckled 3
- 3(2). Wings not speckled; legs lightly speckled; female abdominal terga II-VII without apical and basal bands or apicolateral pale spots Selangor form
Wings lightly or moderately speckled; legs lightly or moderately speckled; female abdominal terga II-VII with or without narrow apical and basal bands, but with apicolateral pale spots . . . 4
- 4(3). Legs and wing lightly speckled; female abdominal terga II-IV with or without very narrow apical pale bands; basal pale bands narrow, incomplete or absent *tenax* form
Legs and wings moderately speckled; female abdominal terga II-IV with narrow apical and broad basal pale bands Luzon form
.

MALE GENITALIA

1. Apical spiculate portion of inner division of lateral plate long, typically beaklike, apical margin smoothly curved, apical tergal angle blunt or not produced (Fig. 1A)
 *bitaeniorhynchus* (typical form)
 Phallosome as above but with emarginate apical margin or short, stout with apical tergal and sternal angles produced into points 2
- 2(1). Apical spiculate portion of phallosome long, beaklike, emarginate distally, apical sternal angle conspicuously longer than apical tergal angle (Figs. 1B,C)
 *tenax* form and *domesticus* form
 Apical spiculate portion of phallosome short, stout, convex, apical tergal and sternal angles more or less equally produced 3
- 3(2). Apical spiculate portion of phallosome as in Fig. 1D
 Selangor form
 Apical spiculate portion of phallosome as in Fig. 1F
 Luzon form

PUPA

1. Metanotal hair 11-C and abdominal hairs 3-I-III usually single *bitaeniorhynchus* (typical form)
 Metanotal hair 11-C and abdominal hairs 3-I-III usually double 2
- 2(1). Outer part of paddle with dark external margin in basal 0.5; cephalothorax and abdomen pale; alveoli of abdominal hairs surrounded by dark spots on all segments, producing striking pattern *domesticus* form (in part)
 Outer part of paddle with or without dark external margin in basal 0.5; cephalothorax and abdomen deep yellow, dark brown, without dark alveolar spots or if pale, with lightly pigmented alveolar spots 3
- 3(2). Cephalothorax and abdomen pale, with more or less striking pattern of dark alveolar spots on abdominal segments
 Selangor form
 Cephalothorax and abdomen deep yellow or dark brown without striking pattern of dark alveolar spots on abdominal segments 4
- 4(3). Basal external margin of outer part of paddle dark
 *domesticus* form (in part)
 Basal external margin of outer part of paddle pale
 *tenax* form and luzon form

LARVA

1. Siphon with 8 subventral tufts . . . *bitaeniorhynchus* (typical form)
Siphon with 6 subventral tufts 2
- 2(1). Comb scales small, 9-12 in number Selangor form
Comb scales large, spinelike, 4-5 in number 3
- 3(2). Most abdominal hairs strong, dark and very distinct.
. *domesticus* form
Most abdominal hairs weak, pale and rather inconspicuous . .
. *tenax* form and Luzon form

CHARACTERIZATION OF BITAENIORHYNCHUS FORMS

1. BITAENIORHYNCHUS (typical form)

FEMALE (Fig. 2A). Head. Erect scales on vertex usually pale, yellowish or whitish in center, dark brown to black on posterolateral areas. Thorax. Anterior 2/3 of mesoscutum usually pale whitish or yellowish, rarely predominantly light brown or dark with mottling of golden or yellowish scales on acrostichal and dorsocentral areas or elsewhere; posterior 1/3 of mesoscutum predominantly dark brown except for some pale scales in middle of prescutellar space; scutellar lobes with some pale scales on apical margin. Legs and Wings. Extensively speckled. Abdomen. Terga II-VII always with broad apical yellowish bands, varying from 0.25 to 0.5 of segment width; tergum VIII with broad apical and basal yellowish bands, dark areas on all terga usually extensively speckled.

MALE. As in female except for less extensive speckling of wings. Genitalia (Fig. 1A). Apical spiculate portion of inner division of lateral plate of phallosome typically beaklike, variable in length, usually long with smoothly curved apical margin, apical tergal angle blunt or obtuse; basal sternal process of proctiger rudimentary, slender, and varying from 0.01 to 0.04 mm. in length.

PUPA. Cephalothorax and abdomen pale whitish or light yellowish with indefinite dark areas; alveolar spots of all abdominal hairs usually dark, producing a striking pattern on all segments, rarely absent; metanotal hair 11-C and abdominal hairs 3-I-III usually single, rarely double; inner part of paddle usually darkened, outer part pale, basal 0.5 of external margin of outer part pale.

LARVA. Most abdominal hairs except 6-I-VI and 7-I very weak, indistinct; hairs 1-III-VI weak, 2 or 3-branched; hair 4-V weak, pale, 7-9-branched; 4-VI 3-5-branched; comb scales large, spinelike, usually 4 or 5 in number; siphon with 8 subventral tufts.

DISTRIBUTION. The typical *bitaeniorhynchus* form is widely distributed throughout the Oriental region. Within Southeast Asia it has been recorded from Thailand, S. Vietnam, Malaysia, Singapore, Indonesia, Philippines, Hainan (China), Hong Kong and southern Ryukyus.

DISCUSSION. I am following Edwards (1922) in using the name "*bitaeniorhynchus*" for this form in spite of the fact that the type is lost. The only other type which is still in existence and is apparently the one used by Edwards (1922) in referring to this form is that of *C. ager* (Giles, 1901). The only other nominal form to be placed with the typical form of *bitaeniorhynchus* is *C. karatzuensis* Mochizuki, 1913 from Japan, which was synonymized by Edwards (1932).

The typical *bitaeniorhynchus* form has been most frequently found breeding in association with the *domesticus* form in Malaya, Thailand, Vietnam and Borneo, occasionally with *tenax* forms in Thailand and Malaya and with the *Luzon* form in the Philippines. However, towards the north, including Thailand, Hainan, Hong Kong, Ryukyus and Japan, the populations are quite homogeneous, apparently consisting of only the typical form as interpreted here. The only variation that would cause some confusion is the color of scales on the anterior 2/3 of mesoscutum which may be predominantly dark brown in some adult specimens. This form agrees best with the figure of adult habitus in LaCasse and Yamaguti (1950: 202) and with the figures of the male phallosome and larva in Bram (1967: 262, 264).

2. TENAX FORM

FEMALE (Fig. 2C). Head. Erect scales on vertex varying from predominantly dark brown to partially pale, bronzy in center, dark on posterolateral areas. Thorax. Anterior 2/3 of mesoscutum with pale scales as in the typical form or predominantly dark brown with extensive mottling of yellow or golden scales forming distinct blotches on fossal, acrostichal and dorsocentral areas, posterior 1/3 of mesoscutum entirely dark; scutellar lobe with or without some golden or yellow scales on apical margin. Legs. Lightly to moderately speckled, sometimes almost completely dark or with speckling of yellow scales restricted to apical 0.5 on anterior surfaces of mid- and hind femora, sometimes also on fore femur. Wings. Usually lightly to moderately speckled, rarely heavily speckled, sometimes completely dark. Abdomen. Terga II-IV usually entirely dark dorsally, with pale yellowish apicolateral spots which may extend dorsad forming very narrow apical bands; terga V-VII usually with narrow apical yellowish bands connecting with larger yellowish apicolateral spots at sides; tergum VIII with broad basal and apical yellowish bands; terga II-VII with or without median basal pale spots or complete basal pale bands.

MALE (Fig. 2D). Differs from female in having both apical and basal bands on abdominal terga II-VII, the basal broader than the apical; scales on anterior 2/3 of mesoscutum always pale and less extensive speckling of legs and wings. Genitalia (Fig. 1C). In general, resembles the typical form of *bitaeniorhynchus*, but differs as follows: apical spiculate portion of inner division of lateral plate of phallosome with distinct emargination on apical margin, apical tergal angle produced into point; basal sternal process of proctiger usually long, slender, 0.04-05 mm. in length.

PUPA. Cephalothorax and abdomen more or less uniformly deep yellow; alveolar spots absent; abdominal segments V-VIII with or without lateral pairs of dark spots and dark median basal spots; metanotal hair 11-C and abdominal hairs 3-I-III usually double, rarely single; inner and outer parts of paddle pale, basal 0.5 of external margin of outer part usually pale or slightly darkened.

LARVA. Essentially as in the typical form of *bitaeniorhynchus* but with only 6 subventral tufts on siphon.

DISTRIBUTION. The *tenax* form is apparently restricted to the Indomalayan part of the Oriental region. In Southeast Asia it is recorded from Malaya, some parts of Thailand and possibly from the Philippines. The Philippine records from Leyte Island are not certain since they are based on adults only.

DISCUSSION. The *tenax* form is most difficult to characterize. It shows a great deal of overlap with typical *bitaeniorhynchus* and other forms described below. The following nominal forms which are considered as conspecific with this form are: *ambiguus* (Theobald) from India; *taeniorostris* (Theobald) from Ceylon; *tenax ocellata* (Theobald) and *sarawaki* (Theobald) from Sarawak, Borneo. The general adult habitus of the *tenax* form does not agree with any previous published figures of *bitaeniorhynchus*, particularly with regard to the banding of the abdominal terga. In the association of all stages of the *tenax* form from various collections in Malaya, it was found that the female differs from the male in the almost complete absence of basal bands on abdominal terga II-VII, although both sexes agree in most other features as well as in their correlated larval and pupal skins. The male obviously agrees very well with the *ambiguus* type male from India and *pseudosinensis* Colless from Singapore (see Bram 1967: 267). The females are very variable in the color of scales on anterior 2/3 of mesoscutum and speckling of legs and wings, but appear to be more or less constant in the dark abdominal terga II-IV or II-V, agreeing well with the type females of all other nominal forms mentioned.

The *tenax* form is apparently common in Malaya where it has occasionally been found in the same breeding site with typical *bitaeniorhynchus* and *domesticus*. However, it appears to be much less abundant than the latter two forms.

3. SELANGOR FORM

FEMALE. Very similar to the *tenax* form, differing as follows: Thorax. Anterior 2/3 of mesoscutum always covered with whitish scales. Legs. Lightly speckled. Wings. All scales dark. Abdomen. Terga II-VII entirely dark, with very light sprinkling of pale scales; tergum VIII with very narrow basal band, remainder dark; apicolateral yellowish spots absent on all segments.

MALE. Differs from the female in less extensive speckling of legs and in having large pale, median basal spots on terga II-VII which may form complete basal bands. Genitalia (Fig. 1D). Very similar to *C. pseudosinensis* Colless (Fig. 1E). Apical spiculate portion of inner division of lateral plate dark, with apical tergal and sternal angles produced into a point; basal sternal process of proctiger well developed, about 0.05 mm. in length.

PUPA. Rather similar to typical *bitaeniorhynchus* in the color of cephalothorax, abdomen and paddle. Alveolar spots of abdominal hairs distinct but not as striking; metanotal hair 11-C 2-3 branched; abdominal hairs 3-I-III double.

LARVA. All abdominal hairs except hairs 6-I-VI and 7-I extremely weak, indistinct; comb scales small, 9-10 in number, as in *pseudosinensis* (See Bram, 1967: 269); siphon with 6 subventral tufts.

DISTRIBUTION. The Selangor form is known only from a small number of reared specimens from a single collection in Selangor, Malaya.

DISCUSSION. The Selangor form, is apparently rare. In the single known collection from Malaya, it was not found to be associated with any other forms of *bitaeniorhynchus*. It is fairly close to *C. pseudosinensis* Colless (Bram, 1967: 265), but can be differentiated from it in the female by the complete absence of apical or basal bands on abdominal terga II-VII and the presence of light speckling on the legs; in the male, by the slightly different shape of the phallosome; in the pupa by much paler cephalothorax and abdomen. The larva is identical to *pseudosinensis* in the size and number of comb scales and in number of siphonal tufts and cannot be separated from it with certainty. In the overall morphology, this form is rather intermediate between *tenax* or *bitaeniorhynchus* and *pseudosinensis*, strongly suggesting that it may be derived through hybridization between these forms. The Selangor form may prove to be distinct, but for a final decision more specimens are needed.

4. LUZON FORM

FEMALE. Generally similar to the *tenax* form, differing from it as follows: Head. Erect scales usually whitish in center, dark on posterolateral areas. Thorax. Anterior 2/3 of mesoscutum predominantly light brown to dark brown, with mottling of whitish or yellowish scales at level of anterior wing roots; prescutellar space with some pale scales in middle; scutellar lobe with some pale scales on apical margin. Legs. Moderately speckled or sometimes nearly completely dark. Abdomen. Terga II-IV with broad basal bands and apicolateral spots only; terga V-VII with narrow apical and broad basal bands; all basal bands produced in middle.

MALE. Differs from the female in having mesoscutal scales almost entirely pale yellowish or very light brownish. Genitalia (Fig. 1F). Apical spiculate portion of lateral plate of phallosome dark, stout, with short sternal apical beaklike process, apical tergal angle produced into a point; basal sternal process very well developed, rather thick, about 0.08 mm. in length.

PUPA and LARVA. Essentially as in the *tenax* form.

DISTRIBUTION. The Luzon form is recorded from the mountain provinces of Bagiuo and N. Viscaya in Luzon the Philippines.

DISCUSSION. The Luzon form is dominant in the localities where it was collected. Most of these collections contain some specimens of typical *bitaeniorhynchus*. It appears to be closer to the *tenax* form than any other, but can be differentiated from it by the type of the male phallosome as figured and as indicated above. Whenever specimens from progeny rearing become available, it may prove to be distinct.

5. DOMESTICUS FORM

FEMALE (Fig. 2B). Head. Erect scales on vertex entirely black, rarely partially golden or dark bronzy in center and dark towards posterolateral areas. Thorax. Mesoscutum usually entirely black or deep chestnut brown, sometimes also with bronzy or golden brown scales forming spots or streaks in the middle or elsewhere; prescutellar space without pale scales; scutellar lobes without pale scales toward apical margin. Legs. Lightly to moderately speckled, sometimes heavily speckled. Wings. Speckled as on legs. Abdomen. Very similar to the *tenax* form in having terga II-V predominantly dark; differing in having terga VI-VII with broader apical yellowish bands, tergum VIII usually entirely yellowish; dark tergal area on terga II-VII more extensively speckled.

MALE. As in the female except for less extensive speckling of legs and wings, and for the following: Abdomen. Terga II-IV usually with very narrow apical bands and very small median basal spot, sometimes without apical bands; terga V-VII with rather broad apical bands and small basal median pale spots; terga VIII completely yellowish or sometimes with broad apical and basal bands; dark tergal areas lightly to heavily speckled. Genitalia (Fig. 1B). Essentially similar to the *tenax* form.

PUPA. Cephalothorax and abdomen variable in color, usually pale as in the typical *bitaeniorhynchus* form, alveolar spots of all abdominal hairs usually dark, producing striking spotted pattern; sometimes color of cephalothorax and abdomen deep yellow to dark brown as in the *tenax* form and alveolar spots of abdominal hairs not developed; metanotal hair 11-C and abdominal hairs 3-I-III usually double, as in *tenax*; paddle with inner part pale and usually with basal external margin of outer part very dark, sometimes pale.

LARVA. Most abdominal hairs except hairs 6-I-VI and 7-I relatively strong, dark and conspicuous; hairs 1-III-VI 4-5 branched; 4-V 10-15 branched; 4-V usually 6 branched (5-7); comb scales and number of subventral tufts of siphon as in the *tenax* form.

DISTRIBUTION. The *domesticus* form is dominant in southern Thailand, South Vietnam, Malaya and Borneo and it is quite possible that it may also occur in other adjacent areas, including India, Burma and Indonesia. It has not been seen in the Philippines or anywhere else in the north or northeast in Hainan, Hong Kong, Ryukyus and Japan.

DISCUSSION. The *domesticus* adults are darkest of all the *bitaeniorhynchus* forms and can be readily recognized with the naked eye. The general adult habitus agrees best with the figure in Bram (1967: 259). The female of *domesticus* may be only confused with that of *tenax* which it overlaps in color of the abdominal terga. The male is also rather similar to *tenax* except for the predominantly dark mesoscutum and the incomplete basal bands on abdominal terga. In addition the male phallosome is indistinguishable from that of *tenax*. The pupa is apparently variable, showing overlap with the typical *bitaeniorhynchus* and *tenax* forms, but with chaetotaxy similar to the latter. The larva is obviously quite distinct in that most abdominal hairs are stronger, darker and more conspicuous than those of any other form.

The *domesticus* form is apparently more common and more widely distributed than the *tenax* form and is more frequently found associated with the typical *bitaeniorhynchus* than *tenax*. In the Malayan populations, the adult characters show a great deal of overlap with those of *tenax*, particularly in the light speckling of legs and wings, but in the populations from northern Thailand, these features are more strongly developed and more or less similar to those noted in typical *bitaeniorhynchus*. It is possible that we may be dealing here with 2 or more forms of *domesticus*. The only other nominal form considered synonymous with *domesticus* is *infula* (Theobald) from Malaya, which may actually belong to *tenax*. Because of the limited amount of reared material and the lack of specimens from progeny rearings, it is not possible at present to arrive at any definite conclusions about them.

FREQUENCY OF FORMS IN THE MALAYAN POPULATIONS
OF BITAENIORHYNCHUS

The relative frequency of 3 forms (*bitaeniorhynchus*, *domesticus* and *tenax*) in 10 collections from Malaya is shown in the table below. From 7 to 28 reared adults with associated pupal, or pupal and larval skins are represented in the various collections.

Coll. No.	Total Number of Specimens	Forms		
		<i>bitaeniorhynchus</i>	<i>domesticus</i>	<i>tenax</i>
560	13	-(0%)	4(30%)	9(70%)
574	28	12(45%)	16(55%)	-(0%)
636	24	24(100%)	-(0%)	-(0%)
703	18	2(10%)	4(20%)	12(70%)
811	7	-(0%)	7(100%)	-(0%)
930	17	-(0%)	8(47%)	9(53%)
1404	14	11(80%)	3(20%)	-(0%)
1445	10	10(100%)	-(0%)	-(0%)
1460	14	7(50%)	7(50%)	-(0%)
1894	8	1(10%)	7(90%)	-(0%)
Total	153	67(45%)	56(38%)	30(17%)

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Fig.1 TYPES OF MALE PHALLOSOME IN CULEX BITAENIORHYNCHUS
(Lateral View)

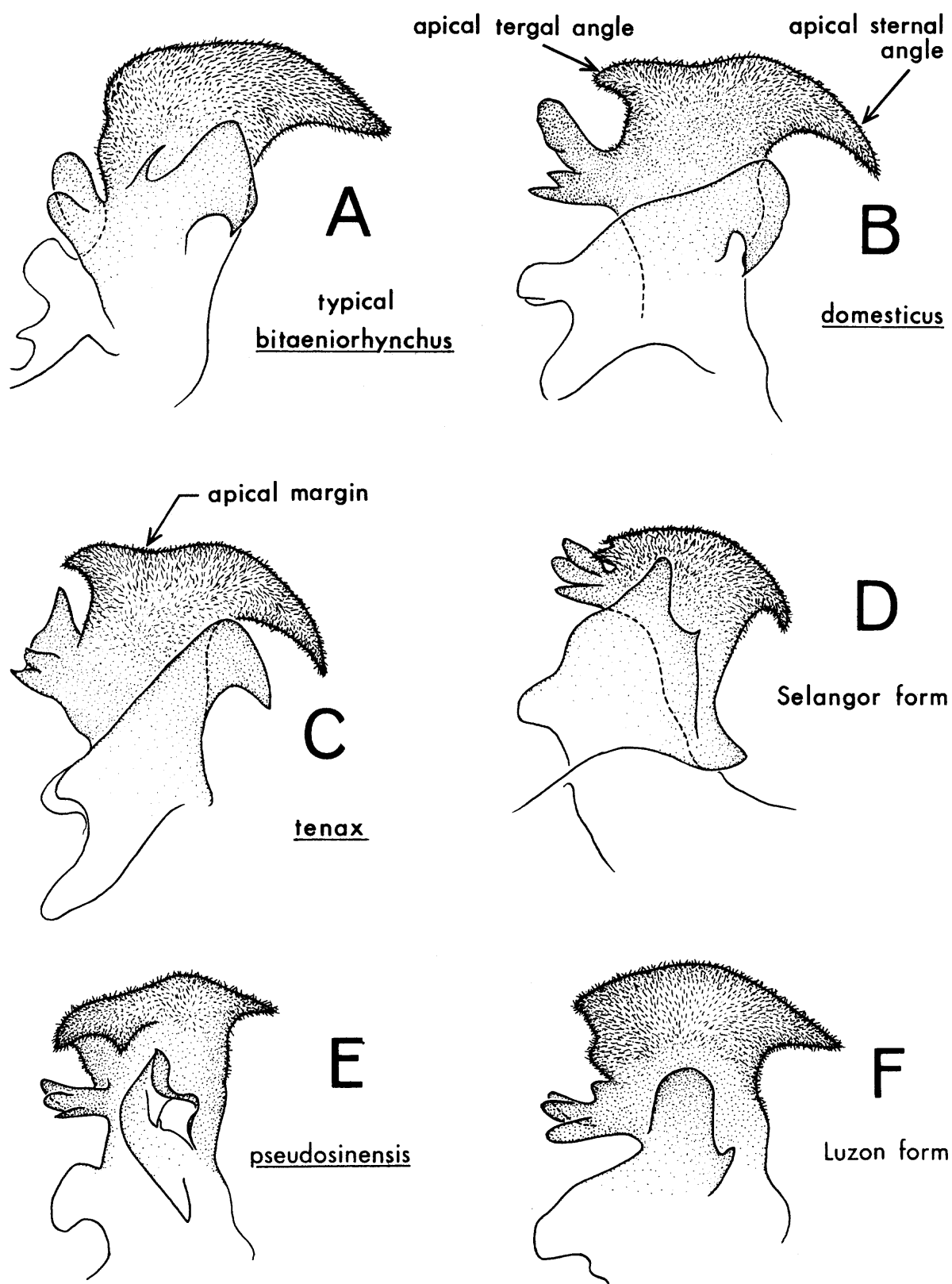


Fig. 2 COLOR OF MESONOTUM AND ABDOMEN OF
BITAENIORHYNCHUS FORMS

